APPENDIX A

STEP-BY-STEP PREPARATION OF MAMMOTH BONES (JACKETS #8, #11 AND #16) FROM SITE 41BX1239, BEXAR COUNTY, TEXAS

THE MAMMOTH SITE OF HOT SPRINGS, SD, INC.
REPORT

STEP-BY-STEP PREPARATION OF MAMMOTH BONES
(Jackets #8, # 11 and #16)

From the Site 41BX1239, Bexar County, Texas

Prepared for

SWCA ENVIRONMENTAL CONSULTANTS

WORK AUTHORIZATION NO. 57721SA002

4407 Monterey Oaks Blvd.

Building 1, Suite 110

Austin, Texas 78749

Prepared by

Olga Potapova

Mammoth Site of Hot Springs, SD., Inc.

1800 Hwy 18 Bypass

Hot Springs, SD 57718

August 31, 2011
Abstract

The preparation of bones from jackets #8, #11, and #16, from site 41BX1239, is described in a step-by-step fashion. Recovered remains of at least 11 bones from two mammoths, *Mammuthus* sp., were prepared using reversible consolidants, according to methods developed at the Mammoth Site of Hot Springs, SD, Inc. Recommendations for bone treatment from other jackets recovered from the site are given.

Acknowledgements

I would like to thank all the Mammoth Site personnel for supporting this work. Steve Carpenter (SWCA, Environmental Consultants Austin, TX) have been a key person providing all necessary information on field work and preliminary archeological and paleontological analyses of the 41BX1239 site and coordinating this work between Mammoth Site and SWCA. Faye Fessler, the Mammoth Site preparator (Hot Springs, SD) and Connie Jacobus, Mammoth Site volunteer (Madison, WI) conducted most of the project preparation work, with the assistance of internship students, Chelsea Payne (University of Wisconsin-River Falls, River Falls, WI), and Lindsey Yelder (Augustana College, Rock Island, IL). I am very thankful to the anonymous technical editor from Hot Springs, SD for her professional work on this draft.
Table of Contents

Introduction .................................................................................................4
Methods ........................................................................................................6
Step-by-Step Preparation Techniques with Recommendations for Further Preparations ..................8
  1. The Jacket Removal ...........................................................................8
  2. The Sand Screening .........................................................................11
  3. The Bone Preparation and Consolidation .........................................11
Conclusions/Recommendations .................................................................22
References .................................................................................................23

List of Tables

Table 1. Tabulated results of the faunal study ...........................................5

Appendices

Appendix A  Selected jackets for the preparation at Mammoth Site
Appendix B  Photos of selected specimen preparations (jacket #11)
Introduction

Site 41BX1239 is located on the western terrace of the San Antonio River less than 0.5 km downstream from its confluence with the Medina River, approximately 6.75 miles south of San Antonio, and about 3.5 miles west-southwest of Elmendorf, in southern Bexar County, Texas. The site was discovered in 1997 by archeologists from the Center for Ecological Archeology at Texas A&M University. They reported 1,667 bones discovered at the site’s Trench #7, characterized as the “bonebed.” The bonebed contained the remains of at least one mammoth skeleton (Mammuthus sp.), possibly a Columbian mammoth (Mammuthus columbi), within the southeastern right-of-way quadrant of the Interstate Highway 37 (I-37) bridge crossing (Lawrence et al., 2007).

Due to evidence of butchering marks discovered on three mammoth bones (unidentified fragments of unknown sizes, specimens #121, 122 and 123), the location was considered to be an archeological site (Lawrence et al., 2007). Based on stratigraphy, the date of deposits at the site was estimated to be between 10,500 – 15,000 yrs B.P. The site could potentially add information on human-mammoth interaction studied at the other mammoth-hunting sites in Texas (Grayson and Meltzer, 2002).

In late May and June 2007, SWCA conducted archeological investigations for the I-37 bridge project in Bexar County, Texas, to address the requirements of Section 106 of the National Historic Preservation Act (1966), as Amended, and the Antiquities Code of Texas. Kevin Miller (SWCA), Principal Investigator, conducted work under Texas Antiquities Permit 4531, with General Services Contract #577XXCA002, and Amended Work Authorization #57709SA002 (Lawrence et al., 2007).

According to the contract between SWCA and the Mammoth Site of Hot Springs, SD, Inc., (SWCA DOT contract # 57-7XXSA002, work authorization 21, continuation of Work Authorization #57-713SA002), the Mammoth Site received three large boxed jackets containing mammoth bones for further preparation, consolidation and faunal analyses, with work to be completed by August 31, 2011. Three jackets (or bins), #8, #11, and #16, were mutually selected by the Mammoth Site and SWCA out of about 20 jackets for this project (Appendices A and B). The selection was made based on the preliminary bone identifications by SWCA in the field, and the bones’ significance for taxonomic identifications. The bones in the jackets were preliminarily identified by the SWCA investigators as follows:

**Jacket 8** – Patella (B-37), astragalus (B-38), un-diagnostic cluster

**Jacket 11** – Tooth, mandible (B-29E, B-29W)

**Jacket 16** – Proximal humerus (B-30)
After the bones from jackets #8, #11, and #16 were prepared and stabilized, the following identifications of the bones were made (Table 1; Potapova & Agenbroad, 2011):

**Table 1. Tabulated results of the faunal study, according to received plaster jackets.**

<table>
<thead>
<tr>
<th>Jacket (bin #)</th>
<th>Bone #</th>
<th>Field Bone ID by SWICA</th>
<th>Bone ID in this study</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>B-37</td>
<td>Patella, Undiagnostic cluster</td>
<td>Right Patella</td>
<td>Complete element</td>
</tr>
</tbody>
</table>
| 8             | B-38   | Astragalus (possible) And Bone-large cluster | A. Right femur lateral condyle, large fragment with portion of the shaft  
B. Right femur lateral condyle, large fragment  
C. Femur condyle small fragment, possibly portion of the fragment “B”.  
D. (?) Femur shaft fragments  
E. Rib fragment | No astragalus was recovered/ identified. Right femur condyle fragments B and C are glued together |
| 11            | B-29E/ B-29W | Mandible And Tooth | A. Right Mandible large fragment  
B. Right Mandible large fragment  
C. Small mandible fragment  
D. Right Large bone cluster (including small rib fragments) | Three pieces of mandible, A, B, and C are glued together |
| 16            | B-30   | Proximal humerus | A, B. Right Humerus diaphysis with large distal portion  
B. Rib fragments | A and B not glued together (missing pieces), but are placed in one jacket |
Methods

The Mammoth Site’s experience in preparation of mammoth bones “in-situ” and in laboratory conditions goes back to 1974, when the site was discovered by a local bulldozer operator and shortly thereafter, Dr. Larry D. Agenbroad became involved in excavations, salvation, and preservation of the unearthed remains (Agenbroad, 1994). First results of mammoth bone conservation experience were published in 1994 (Anderson et al., 1994). This paper summarized the use of terpolymer polyvinyl butyral (B-76/acetone and B-98/ethanol), and the testing of Acrysol (Anderson, 1989,) after the temporary usage of the Glyptal, which was discontinued in 1986. Butvars are the most widely used in conservation as consolidants (Horie, 1987); due to their $T_g$, low yellowing tinge, penetration ability, reversibility (with acetone), and slow rate of deterioration, they were considered the most appropriate for further non-petrified bone conservation (Saunders, 1986; Snider, 1988; Patterson, 1989).

After conducting the Conservation Assessment of the Mammoth Site of Hot Springs, SD, as a part of the IMLS CAP program, Fitzgerald (2005) recommended using Acryloid B-72 (Paraloid B-72) in laboratory conditions, due to its lower rate of yellowing. Since then, the specimens removed from the bonebed are consolidated with Acryloid B-72, and repairs are made using B-76.

Mammoth bone preparation techniques were further tuned, based on work done on the “in-situ” bonebed, containing over 1,200 mammoth bones, and on over 1,500 bones removed from the bonebed and stored in environmentally controlled conditions (Potapova, 2002, 2003, 2004, 2008; Potapova et al., 2002, 2010; Thompson et al., 2007). As of the 2011 season, the bone remains come from 118 tusks and skeletal remains, representing 59 mammoths (Agenbroad, pers. comm. August 2011).

In preparing the specimens from site 41BX1239, Acryloid B-72 was used. The consolidant was applied using venting wash bottles. The following solutions of the consolidant were used:

1. 2 oz B-72/0.5 gal acetone
2. 4 oz B-72/0.5 gal acetone
3. 6 oz/0.5 gal acetone
4. 8 oz B-72/0.5 gal acetone
5. 16 oz B-72/0.5 gal acetone

Different concentrations of B-72 were necessary for preparation due to different conditions of the bone fragments. For example, bones with a lot of cortical matrix were
consolidated with the thinnest solution, allowing deep penetration; and bones with a lot of cancellous structure were consolidated with the thickest solution (16 oz B-72/0.5 gal acetone).

Acetone (in venting wash bottles) was applied by saturating paper towels surrounding the bone fragments, allowing its quick evaporation. Using water (slow evaporation) instead would have jeopardized the integrity of the bones. Fragments removed from the paper towels were checked for dryness, and immediately consolidated with B-72.

Fragments were glued together using Butvar 76/acetone mixed in an approximately 50:50 ratio. Sand tables were used for aligning the bones in an erect position (as if the mammoth were standing upright).

Cheesecloth rags wetted with acetone were used in cleaning the bone surfaces of adhering sediment and soil stains. The acetone-soaked rags were applied to the bone for 5, 10, or 15 minutes, depending on each bone’s size, structure and condition. The acetone-soaked rags were also covered by plastic wrap, to slow the evaporation rate. Small fragments were cleaned without soaking in acetone by rubbing their surfaces with an acetone-soaked rag or toothbrush.

Air scribes (MicroJack #5, and air scribe ME-9100 with 2” bushing and 3” stylus – see http://www.paleotools.com/products.html), brushes, dental picks, and wooden sticks were used for the sediment removal. Magnifying lamps (4x) were utilized during air scribing and also used for close examination of bone surfaces in order to avoid possible scratches.

All preparation activities (except cutting plaster jackets) took place in the laboratory conditions at enclosed cubicles equipped with a ventilation system.
Step-by-step preparation techniques with recommendations for further preparations

1. The jacket removal

The jackets containing bones from site 41BX1239 were received in different states. As it appeared, jacket #16 contained a mammoth humerus (B-30) surrounded by thick coat of dirt. Jacket #16 may have been the original “field” jacket. Jackets #8 and #11 were made in SWCA lab conditions. SWCA had placed the bones from jackets #8 and #11 on sand, which filled the lower half of each plaster jacket. The bones were then wedged in place with (?) water-soaked paper towels. Half-jackets were then applied to the individual bones, or bone clusters, and finally the upper half of the plaster jacket was sealed in place over all the bones in that jacket.

When the jackets arrived at the Mammoth Site, each jacket was cut along the horizontal edge, with the top (label sides) up.
Jacket #11 (mandible B-29E/B-29W)

Jacket #11 ("tooth" B-29E/B-29W)

Jacket #16 (humerus B-30) partially opened

Jacket #16 (humerus B-30) cut open
We started the preparation work with jacket #11 (mandible and “tooth”): The jacket was cut into two halves; the top jacket half was lifted from the bottom half and flipped over. The top jacket appeared to hold most of the bones packed between paper towel wedges, but many of the fragments were left on the bottom jacket half that was filled with sand. Once the fragments were picked out of the sand, it was difficult to identify the fragments, and which parts of the bones they had come from. The sand is a very loose material, and it should not have been used as a supporting matrix for jacketing the bones.

Under the circumstances, we had to change the strategy for extracting the bones from the remaining jackets, which is the method we recommend for treating other jackets where bones have been placed on sand.

First, we cut the plaster jacket in half as described above, revealing the individual half-jackets covering the individual bones from the top. Then, we removed the sand from the bottom of the plaster jacket using scoops and brushes, and later screened the sand for bones bottom (see photos below). After the bottom jacket was cleaned of sand the halves were secured together, and then flipped over. As the result, the bones contained in the former top jacket were left safely resting in it, upside-down, being held by wedged paper towels, and ready for further preparation.

Jacket #16 was comparatively trouble free. It did not need to be flipped over to get rid of the sand, so we did not need to implement extra measures to protect the bones.
2. The sand screening.

Sand removed from the bottom half-jackets (jackets #8 and #11) was bottoms screened for bone fragments, so those could be pieced together.

The largest bone fragments were pieced together with the mandibular fragments (jacket #11), and the “tooth.” Remaining fragments, which we could not match with other bone fragments, were consolidated with Acryloid B-72, labeled and boxed.

2. The bone preparation and consolidation.

Actual bone cleaning, preparation, and piecing together fragments occupied most of the budgeted time for the project.

In addition to screening sand for bone fragments, the preparation of the bones removed from jackets #8 and #11 involved the removal of bone fragments from the paper towel wedges. The towels were slightly moistened along the bone edges, and after few minutes of soaking, the fragments were slowly removed with tweezers. Each removed fragment was checked for dryness, and immediately consolidated with the Acryloid B-72 thin (2 oz/0.5 gal acetone) solution.
Faye Fessler preparing the bone B-29E/B-29W, “tooth” and its original (un-prepared) condition from different sides. A few ribs fragments are visible on the lower left image.

After the bones were removed from the jackets (except humerus, jacket #16), the bones were cleaned of sediment. Small amounts of acetone were applied on the sediment to soften it, which was then quickly removed. Using acetone instead of water allowed fast evaporation and prevented the bones from getting wet.

During the bone preparation, the cleaned bone surface was consolidated with Acryloid B-72. This gradual application was repeated on all the bones.
The end product of preparation of the “tooth” after the sediment was removed (viewed from both sides. A few ribs are visible on the right image.).

The preparation of the “tooth” from jacket #8 (B) revealed that it represents a conglomerate of bones, that includes rib fragments.

All three mandible fragments were prepared and consolidated. Shown below are images of two of the mandible fragments prior to preparation.

The mandible fragment A (B-29E/B-29W) from both sides after removal from the jacket
The mandible fragment B (bone # B-29E/B-29W) from both sides after removal from the jacket. Molar root remains are visible on the upper right image.
View of the reconstructed right corpus fragment of mandible from the lateral side (fragments A, B and C are glued together)

View of the reconstructed right corpus fragment of mandible from the medial side (remaining roots from broken-off molar are visible in the right half of the bone)
Preparation of the bones from jacket #8 ("astragalus") was a little more challenging. The larger fragment of the “astragalus” presented at first as an unrecognizable conglomerate of bones, which was hard to clean of sediment. It was identified later as distal femur condyles. As it appeared, the femur’s shaft was partially gone. Its remaining lateral side was broken off and shifted in the caudal direction, held in place by sediment. Most of the bone’s surface was covered by dirt, soft and hard sediment. Hard sediment was removed using air scribes.

Faye Fessler is preparing the femur distal lateral condyle A (B-38, A), and it’s almost prepared condition is on the lower right.

The femur distal lateral condyle B (B-38, B) is on the upper right and lower left.
Prepared right distal femur lateral condyle (B-38 A), from ventral (left) and lateral (right) views

Prepared right distal femur lateral condyle (B-38 B, and C) from ventral (left) and lateral (right) views
Preparation of the humerus is demonstrated below. Bone condition was very poor. The bone is made up of over a hundred fragments. The fragmented parts of the humerus (mostly proximal part) are supported and held together by sediments. The bone's proximal part is covered by multiple cracks: it was flattened (crushed) latero-medially, probably due to the weight of sediments.

*The right humerus shaft partly cleaned of sediment (deep crack separates fragments A and B)*

*Consequent stages of humerus (B-30A, B) preparation by Faye Fessler: proximal fragment (B) in sediment is removed to allow detailed preparation and piecing together fragments at the bone’s end.*
The right humerus fragment B-30, B (with the rib B-30, C) is removed from the jacket for further preparation.

During preparation, the humerus fragment A fell apart into two pieces (a+b): it was obviously held by the hardened sediment. Both pieces were glued together in a sand box, in a vertical position, which insured its correct alignment.

The humerus (B-30, A) fragments Aa and Ab with applied Butvar 76/acetone glue (image above)

The fragments B-30A (a+b) glued together in up-right position (right image)
Faye Fessler applying Butvar B-76/acetone glue in the cracks, after the pieces were glued together. This procedure was repeated several times, to reinforce the bond.

Right humerus (B-30) in prepared condition, from the left: cranial, caudal, medial and lateral views.
The patella (B-37) in prepared condition from different sides

- **Cranial view**
- **Caudal view**
- **Medial**
- **Lateral**
Conclusions/Recommendations

The following bones were recovered and identified from jackets #8, #11, and #16 from site 41BX1239:

1. Mandible (B-29E, 29W, fragments A, B, and C)
2. Unidentified cluster of fragmented bones (B-29E, B-29W, fragment D)
3. Right humerus shaft (B-30, fragments A (a+b), and B)
4. Rib fragment (B-30, fragment C)
5. Right femur lateral condyle (B-38, fragment A)
6. Right femur lateral condyle (B-38 B, fragment C)
7. (?) Right femur shaft fragment (B-38, fragment D)
8. Rib fragments (B-38, fragment E)
9. Right complete patella (B-37)

Based on our experience, one would expect to find in any other jackets produced from site 41BX1239 more bones than initially identified or recovered during the excavations.

Bones appeared in a very poor condition, and gradual preparation was performed on most of them. We recommend cleaning up a small portion of bone (with or without wetting it with acetone), and immediately consolidating it with reversible (with acetone) consolidants: Acryloid B-72/acetone, Butvar B-76/acetone, Butvar B-98/ethanol, or Vinac 15.

When a bone is completely prepared (consolidated, pieced together, etc.) the supporting (bedding) half-jacket should be built for a long-term storage. For larger bones, the clam-jacket (Jabo et al., 2006) should be created, which will allow handling the bone (turning it over) while it is supported at all times.
References


Potapova, O., 2008, The Methods and data collection in fossil bone preparation process: turning scrap material into premium scientific, educational, and exhibit resource. Abstracts 68th SVP


24
<table>
<thead>
<tr>
<th>Bin #</th>
<th>Bone #</th>
<th>Bag #</th>
<th>Bone ID</th>
<th>Comments</th>
<th>PP North</th>
<th>PP East</th>
<th>PP Elev.</th>
<th>PP Depth (cmbd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B-36a</td>
<td>26</td>
<td>Undiagnostic</td>
<td>Irregular level in bone bed, 2 assoc. clusters, assigned bone sub numbers (b-c)</td>
<td>1001.64</td>
<td>999.26</td>
<td>98.36–97.98</td>
<td>34–72</td>
</tr>
<tr>
<td>2</td>
<td>B-36b</td>
<td>26</td>
<td>Undiagnostic</td>
<td>Irregular level in bone bed, 2 assoc. clusters, assigned bone sub numbers (b-c)</td>
<td>1001.64</td>
<td>999.26</td>
<td>98.36–97.98</td>
<td>34–72</td>
</tr>
<tr>
<td>3</td>
<td>B-35</td>
<td>34</td>
<td>Rib, vertebrae</td>
<td>Mammoth bone cluster</td>
<td>1002.24</td>
<td>999.9</td>
<td>98.24</td>
<td>46</td>
</tr>
<tr>
<td>4</td>
<td>B-31</td>
<td>32</td>
<td>Undiagnostic</td>
<td>Mammoth bone cluster</td>
<td>1002.23</td>
<td>998.94</td>
<td>98.28–98.22</td>
<td>42–48</td>
</tr>
<tr>
<td>5</td>
<td>B-33</td>
<td>34</td>
<td>Long bone</td>
<td>Mammoth bone cluster</td>
<td>1002.02</td>
<td>999.26</td>
<td>98.23</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>B-36c</td>
<td>35</td>
<td>Tusk</td>
<td>Mammoth tusk</td>
<td>1002.67</td>
<td>998.83</td>
<td>98.4–98.3</td>
<td>68–85</td>
</tr>
<tr>
<td>7</td>
<td>B-23b</td>
<td>27</td>
<td>Long Bone Midsection</td>
<td>Irregular level in bone bed, fragmented limb?</td>
<td>1001.3</td>
<td>998.76</td>
<td>98.24</td>
<td>46</td>
</tr>
<tr>
<td>8</td>
<td>B-36d</td>
<td>33</td>
<td>Patella, Fragmented Long Bone</td>
<td>Irregular level in bone bed, limb bone heavily fragmented</td>
<td>1001.52</td>
<td>999.15</td>
<td>98.39–98.18</td>
<td>31–52</td>
</tr>
<tr>
<td>9</td>
<td>B-29E</td>
<td>32</td>
<td>Tooth, Mandible</td>
<td>Mammoth bone-tooth, recovered in 2 portions B-29E (east) and B-29W (west)</td>
<td>1002.62</td>
<td>998.82</td>
<td>98.28–98.10</td>
<td>42–60</td>
</tr>
<tr>
<td>10</td>
<td>B-29W</td>
<td>32</td>
<td>Tooth, Mandible</td>
<td>Mammoth bone-tooth, recovered in 2 portions B-29E (east) and B-29W (west)</td>
<td>1002.62</td>
<td>998.82</td>
<td>98.28–98.10</td>
<td>42–60</td>
</tr>
<tr>
<td>11</td>
<td>B-26</td>
<td>28</td>
<td>Long Bone Midsection</td>
<td>Irregular level in bone bed, assoc with B-27, limb-some fragmented, S-78 collected from underneath</td>
<td>1001.79</td>
<td>999.22</td>
<td>98.23</td>
<td>40</td>
</tr>
<tr>
<td>12</td>
<td>B-12</td>
<td>34</td>
<td>Axis</td>
<td>Mammoth bone- Axis</td>
<td>1001.04</td>
<td>999</td>
<td>98.28</td>
<td>172</td>
</tr>
<tr>
<td>13</td>
<td>B-15</td>
<td>34</td>
<td>Process</td>
<td>Mammoth bone- Process</td>
<td>1002.35</td>
<td>999.29</td>
<td>98.29</td>
<td>171</td>
</tr>
<tr>
<td>14</td>
<td>B-16</td>
<td>27</td>
<td>Rib, Vertebrae</td>
<td>Irregular level in bone bed</td>
<td>1001.99</td>
<td>998.76</td>
<td>98.23</td>
<td>47</td>
</tr>
<tr>
<td>15</td>
<td>B-22</td>
<td>26</td>
<td>Undiagnostic</td>
<td>Irregular level in bone bed, bone cluster only partially removed</td>
<td>1001.88</td>
<td>999.72</td>
<td>98.37</td>
<td>172</td>
</tr>
<tr>
<td>16</td>
<td>B-24a</td>
<td>27</td>
<td>Vertebrae</td>
<td>Irregular level in bone bed, Mammoth vertebrae- probably Thoracic</td>
<td>1001.7</td>
<td>998.95</td>
<td>98.28–98.18</td>
<td>42–52</td>
</tr>
<tr>
<td>17</td>
<td>B-24b</td>
<td>27</td>
<td>Vertebrae</td>
<td>Irregular level in bone bed, Mammoth vertebrae- probably Thoracic</td>
<td>1001.7</td>
<td>998.95</td>
<td>98.28–98.18</td>
<td>42–52</td>
</tr>
<tr>
<td>18</td>
<td>B-26a</td>
<td>28</td>
<td>Ulna</td>
<td>Irregular level in bone bed, Ulna (a)</td>
<td>1001.64</td>
<td>999.26</td>
<td>98.36–97.98</td>
<td>34–72</td>
</tr>
<tr>
<td>19</td>
<td>B-26b</td>
<td>28</td>
<td>Proximal Humerus</td>
<td>Irregular level in bone bed, long bone-Humerus, proximal end mostly in N1002 E998 Bag 33</td>
<td>1001.95</td>
<td>999.05</td>
<td>98.24–98.11</td>
<td>46–59</td>
</tr>
</tbody>
</table>

Table 1. Inventory of Mammoth Bones Recovered from Site 41BX1239 (in yellow - selected bones for preparation at the Mammoth Site)
APPENDIX B